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(54) APPARATUS FOR AND METHOD OF EMBOSSING WEB MATERIALS

(71) We, CROWN ZELLERBACH CORPORATION, a Corporation organised and existing under the Laws of the State of Nevada, U.S.A., of One Bush Street, San Francisco, California 94119, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for and a method of embossing paper webs and like materials.

Web materials and especially non-woven web materials are often worked after their formation to impart particular characteristics thereto such as softness and bulk, and such workings are generally effected by passing the web between a pair of rollers having facing juxtaposed surfaces that respectively engage the web along opposite sides thereof. An exemplary instance of such working of web materials is embossing paper webs and the like to impart a design configuration thereto which, at the same time, tends to increase the bulk or thickness of the web and to soften the same.

Conventional embossing apparatus includes one or more rigid steel embossing rollers having patterned surface areas engageable with a web along one side thereof to imprint the embossing pattern thereon, and a platen roller engageable with the web along its opposite side in co-operation with the embossing roller to provide a backing surface to support the web as the pattern is embossed thereon. The platen roller of a conventional embossing apparatus has a rigid steel core and a resilient cover or sleeve confined thereabout defining the backing surface that co-operates with the embossing rollers in application of the compressive force to the web. This resilient sleeve affords the requisite give or yieldability accommodating deformation of the web in the localised areas thereof corresponding to the raised portions of the pattern carried by the embossing roller.

Although embossing apparatus of this type is in extensive use, it does have a number of disadvantages and limitations included among which are the relatively complex, heavy bearings required to support the various rollers at the ends thereof, and which define fixed axes of rotation, for approximately loading or applying the requisite forces thereto so that the embossing pattern is properly applied to the web material, and the strength and mass required for the rollers to adequately resist bowing thereof intermediate the bearing support at their ends. Further, the platen roller because of its solid metal core is heavy and therefore has substantial inertia which, together with the mechanical hysteresis present in the core because of the working tending to be imparted thereto by the embossing forces, produces considerable heat which is an undesirable by-product of the embossing operation.

A much more limiting disadvantage, however, is that such conventional embossing apparatus imparts longitudinal stretching to the web material processed thereby, tending to tear or fracture the web material which necessarily imposes the requirement that the material have a relatively high tensile strength. The reason that such tensile forces are applied to the web material during the embossing operation is believed to reside in the development of velocity differences as between the co-acting surfaces of the embossing and platen rollers caused by the bodily displacement of the resilient sleeve or cover enclosing the rigid metal core of the platen roller. That is to say, whenever any relatively dense (i.e., a non-sponge-like material having a substantial volume of interstitial voids) resilient material is compressed in one direction, it must enlarge in some other direction. In the case of the conventional platen roller, the compressive inward displacement imparted to the resilient cover by the force of the embossing roller pressing thereagainst results in a wave-like outer enlargement or protuberance along the surface of the platen

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roller adjacent the inward depression which results in the surface of the web material in engagement with the platen roller having to traverse a longer path than the surface of the web in engagement with the embossing roller. The consequent tensile stress applied to the web material is evident.

Apparently, as a result of this action, it has been practicably necessary in the past to remove the web material from the platen roller as quickly as possible and immediately adjacent the embossing station so as to minimize the tensile stress applied to the web material. The necessary path of travel thereby dictated for the web material increases the complexity of the embossing operation in that it requires the inclusion of a plurality of guide rollers which also subjects the web material to additional, but non-beneficial, stresses.

Generally, this invention is applicable to a great variety of web materials including any material that is generally enhanced by embossing or other working thereof effected by co-operative rollers including non-woven materials such as conventional paper webs (toilet tissue, towelling, facial tissue, Kraft paper, etc.), and plastics films (polyethylene, for example), synthetic pulp materials such as those comprised either entirely or partially of synthetic plastics fibres, laminates or impregnated webs.

According to the present invention there is provided apparatus for embossing paper and other webs comprising frame structure; a plurality of support members rotatably mounted on the frame structure and at least certain thereof having patterned embossing surfaces engageable with such web to emboss the same with a predetermined configuration, said support members being positioned at angularly spaced locations about a common centre with their axes of rotation oriented in substantially parallel relation, a platen element floatingly confined by the support members with no rigidly fixed axis of rotation and providing therewith facing juxtaposed surfaces engageable with such web to work the same; and means for driving at least one of said support members, said platen element having a backing wall component providing the surface engageable with the web as a backing surface for the embossing process and a pressurizable chamber in communication with the backing wall component along the side thereof opposite its juxtaposed surface to pressure-reinforce the backing wall component with a fluid within the chamber, said backing wall component being depressible in one direction against the force of the fluid acting thereagainst in the opposite direction from within said chamber.

According to a further aspect of the invention there is provided apparatus for embossing paper and other webs comprising frame structure; a plurality of support rollers rotatably carried by the frame structure at angularly spaced locations about a common centre with their axes of rotation oriented in substantially parallel relation, at least certain of the support rollers having patterned embossing surfaces; a deformable platen roller floatingly confined by the support rollers with no rigidly fixed axis of rotation and providing therewith facing juxtaposed surfaces engageable with such web to work the same, and means for rotatably driving at least one of the support rollers.

The present invention also provides a method of working paper webs wherein the web is passed through a plurality of successive stations spaced apart along a predetermined path, each of the stations comprising a support roller rotatably carried by a frame and engaging a platen roller to provide therewith facing juxtaposed working surfaces, the support rollers being rotatably carried by the frame structure at angularly spaced locations about a common centre with their axes of rotation oriented in substantially parallel relationship and at least certain of the support rollers having patterned embossing surfaces, the platen roller being floatingly confined by the support rollers with no rigidly fixed axis of rotation, the surface of the platen roller being deformable by the support rollers at each of the successive work stations.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side view in elevation of apparatus embodying the invention shown in operative association with a web rewinding machine for toilet tissue;

Figure 2 is a front view in elevation of the apparatus from the infeed side thereof looking generally from left to right as the apparatus is shown in Figure 1;

Figure 3 is an enlarged, vertical sectional view of the apparatus taken along the line 3-3 of Figure 1;

Figure 4 is a further enlarged, axial sectional view taken through the platen roller of the apparatus;

Figure 5 is essentially a diagrammatic view depicting the co-operative interengagement of the embossing and platen rollers and the movement of a web advanced through the successive operating stations defined thereby;

Figure 6 is a diagrammatic view illustrating the succession of embossing operations imparted to a web processed by the apparatus; and

Figure 7 is a diagrammatic view, generally similar to that of Figure 5, but illustrating a modified apparatus having an increased number of operating stations.

Apparatus embodying the present inven-

tion may be used either as an independent integer having no particular association with any other web-processing apparatus or, most conveniently, it may be associated with conventional web-processing machinery to contribute to the over-all operation performed thereby. Essentially, the only difference as between such variant uses of the apparatus will reside in the particular manner in which it is supported and, perhaps, the source of power used to drive the various rollers thereof. In the embodiment of the invention illustrated in Figures 1 and 2, the apparatus is illustrated in function association with other web-processing machinery, and specifically, a web rewinding machine of the type used to rewind rolls of toilet tissue from a large parent or supply roll. Only a portion of a typical web rewinding machine is shown in Figures 1 and 2, namely, the backstand portion or frame components thereof and these components are respectively denoted with the numerals 10 and 11. The embossing apparatus 12 includes frame structure 13 having axially spaced side plates 14 and 15 associated with and fixedly secured to the frame components 10 and 11 along the outer faces thereof, such as by bolts 16 and 17. Spacers 18 and 19 may be interposed between the respectively associated frame members 10, 14 and 11, 15 so as to provide the requisite dimensional interrelationship of the apparatus 12 with the associated web rewinding machine.

The apparatus 12 further includes a plurality of co-operative rollers supported by the frame structure 13 for rotation with respect thereto. Certain of the rollers have facing juxtaposed surfaces engageable with a web of material to work the same and, in a more particular sense, to emboss the web with a predetermined configuration. Such plurality of rollers includes a group of embossing rollers 20, 21 and 22 (see especially Figure 5), there being three such rollers in the particular form of the invention shown in Figures 1 to 7. Another of the co-operative rollers constitutes a platen roller 23 which, as explained in detail hereinafter, is supported by the embossing rollers 20 to 22 and co-operates therewith in working a web 24 continuously advanced through the successive operating stations defined by the co-action of the various embossing rollers with the platen roller.

In this respect, the embossing rollers 20 to 22 are angularly spaced about a common centre with their axes of rotation oriented in substantially parallel relation and disposed intermediate the frame plates 14 and 15. The embossing rollers are constrained in such spacial relationship by being journalled for rotation in bearings provided for this purpose which are respectively secured to the plates 14 and 15. The bearing supports for the rollers 22 and 21 are shown in Figure 3 at, respectively, 25, 26 and 27, 28. The bearings 25 to 28 are completely conventional, are bolted or otherwise fixedly related to the frame plates 14 and 15 as is evident in Figure 3, and they respectively support the axles or centre shafts 29 and 30 of the rollers 22 and 21. The bearings for the embossing roller 20 are not specifically illustrated in the drawing, but are substantially identical to the bearings for the rollers 22 and 21 and need not be further considered.

Advantageously, the bearing structures associated with at least one of the embossing rollers 20 to 22 enable such roller to be bodily displaced relative to the others to relieve the compressive force applied to the platen roller 23 and enable the same to be removed from the apparatus for repair and replacement. Any such bodily adjustment afforded for such one embossing roller also enables the gripping or compressive force defined between each of the embossing and platen rollers adjustably to be varied. In the apparatus 12, the adjustable loading is associated with the embossing roller 22 and involves the bearings 25 and 26 thereof. For identification, adjustment or loading devices 31 and 32 are substantially similar both in terms of structure and function and are respectively associated with the frame plates 14 and 15 although the device 31 is along the inner wall of the frame plate 14 whereas the device 32 is disposed along the outer wall of the frame plate 15.

Considering the device 31, it includes an elongated bolt 33 having a threaded shank extending through an internally threaded bore or opening provided in a bracket 34 fixedly secured to the plate 14 by a plurality of cap screws 35. A lock nut 36 enables the bolt 33 to be constrained in any position of adjustment thereof relative to the bracket 34 by being tightened thereagainst. Adjacent its lower end, the shank of the bolt 33 is unthreaded and freely or loosely extends through an opening in an inwardly projecting ledge 37 secured to a pair of spaced apart clamping bars 38 and 39 extending along the inner face of the frame member 14 in substantially contiguous relation therwith and along opposite sides of the axle 29. The shank of the bolt 33 has washers or collars 40 and 41 pinned thereto along opposite sides of the ledge 37 so as to cause the same to be displaced with the bolt relative to the bracket 34 and frame plate 14 while permitting the bolt to be rotated with respect to the ledge.

The spaced apart bars 38 and 39 are each provided with threaded apertures engaged by cap screws 42 that are associated with the bearing 25 and secure the same to the frame plate 14. The cap screws 42 respectively extend through elongated openings 43 in the frame plate 14 that enable the bearing 25 to be displaced with the bolt 33 along the axis

thereof whenever the cap screws 42 are loosened. It will also be apparent that the frame plate has a relatively large elongated opening 44 therein through which the roller shaft 29 passes and which opening enables the shaft and its associated embossing roller 22 to be adjustably displaced with the bolt 33. The dimensional limits of the elongated openings 43 and 44 together with the length of the adjustment bolt 33 and spacing between the bracket 34 and bar 37 define the maximum permissible displacements for the roller 22 and bearing structure 25, and any position of adjustment into which the roller is placed is fixedly maintained by tightening the cap screws 42 which clamp the bearing 25 and bars 38 and 39 to the frame plate 14 and by tightening the lock nut 36 to constrain the bolt 33 against rotation. As previously noted, the adjustment device 32 is substantially the same as the device 31 described in detail, and the same numerals, but with primes, are used to identify respectively corresponding elements thereof.

The embossing rollers 20 to 22 are hard or rigid members having substantially unyielding surfaces and, in the usual instance, are formed from steel. These rollers are substantially cylindrical and, in the form show, have substantially the same diameters. They are also equally spaced, as is shown most clearly in Figure 5, and have embossing configurations along the web-engaging surfaces thereof which, it will be apparent, are juxtaposed with the surface of the platen roller 23 for co-operation therewith in working the web 24. In this reference, the rollers 20 to 22 are each provided with an embossing configuration that contributes to and forms apart of the composite embossing pattern imparted to the web 22 as it moves through the apparatus 12. More particularly, at least certain of the embossing rollers have linear embossing elements, thereby simplifying construction of the rollers and also contributing to an embossed web of improved quality, as subsequently explained. The rollers 20 and 21 (see Figures 3 and 6) have raised embossing ribs on the cylindrical surfaces thereof which are angularly disposed and have dispositions of the order of 45° in the particular form shown. Thus, the embossing ribs on the roller 20 extend angularly in one direction and impart to the web 24 a plurality of linear or uni-directional depressions that are substantially parallel and oriented at approximately 45° relative to the longitudinal axis of the web so that each depression lies in the $-x$, $+y$ and $+x$, $-y$ quadrants of the usual Cartesian co-ordinate system when such depression extends through the origin thereof. Similarly, the ribs on the roller 21 extend angularly in another direction and impart to the web 24 a plurality of linear or uni-directional depressions that are substantially parallel and oriented at approximately 45° relative to the longitudinal axis of the web so that each depression lies in the $+x$, $+y$ and $-x$, $-y$ quadrants of such co-ordinate system when such depression extends through the origin thereof.

The two embossing configurations provided by the rollers 20 and 21 when superimposed one upon another on the web 24, as shown in Figure 6, define a plurality of squares. The embossing configuration of the roller 22 may take any form generally selected to co-operate with the embossing configurations of the rollers 20 and 21 to provide an overall aesthetically pleasing appearance. The roller 22 is sometimes referred to as a spot embosser which is generally taken to mean an embossing roller that supplies a localized or design configuration to a web engaged thereby. In any case, the embossing configuration of the roller 22 is superimposed on the configurations of the rollers 20 and 21 to provide the web 24 with the composite pattern shown at the lower right-hand corner portion of Figure 6.

Each of the embossing rollers 20 to 22 is rotatably driven by means provided for this purpose that may take various forms including an electric motor or other prime mover (not shown) specifically included in the apparatus 12 or by an interconnection of the prime mover forming a part of the machinery with which the apparatus is associated. The latter arrangement constitutes the drive means in the form shown in the drawings in which power is derived from a take-off shaft 45 (Figure 2) extending outwardly through the aforementioned frame member 10 and journalled for rotation with respect thereto in bearing structure 46 secured to the frame member 10 spaced relation therewith *via* a mounting bracket 47. The shaft 45 delivers input torque to a variable speed drive assembly 48 of completely conventional construction which rotatably drives an output sheave 49 having an endless drive belt 50 entrained therabout. The belt 50 is also entrained about a driven sheave 51 forming the input to a variable speed drive assembly 52 that is also completely conventional and has an output shaft 53 connected with the aforementioned shaft 30 of the embossing roller 21 so as to positively drive the same. The drive assemblies 48 and 52 are respectively equipped with reaction pins 54 and 54' connecting the outer casings to the frame components 10 and 14, respectively, to constrain such casing components against rotation.

The shafts or axles 30 and 29 of the embossing rollers 21 and 22 have sheaves 55 and 56 keyed or otherwise secured thereto so as to prevent relative rotation therebetween; and, analogously, the embossing roller 20 is equipped with an axle or shaft 57 having a

sheave 58 keyed thereon. An endless belt 59 is entrained about all of the sheaves 55, 56 and 58 so that all of the embossing rollers are driven concurrently in the same angular directions. The drive belts 50 and 59 may be entirely conventional, and are advantageously tooth-equipped belts engageable with similarly toothed sheaves so that slippage is obviated. A take-up roller 60 may be arranged with the belt 59 so as to impart the desired tension thereto. Ordinarily, a brake system is included in web-processing apparatus to prevent momentum over-runs and otherwise to maintain the tension on the web relatively uniform at all times. A conventional brake mechanism 61 is associated with the shaft 57 of the embossing roller 20 for this purpose, and since it is a standard and well known device no further description thereof will be included.

The platen roller 23, as shown best in Figures 3 and 4, includes a pair of axially spaced end wall components 62 and 63, and a generally cylindrical backing wall component 64 extending therebetween and defining therewith a pressurizable chamber 65 adapted to be filled with a pressurized fluid to pressure-reinforce the backing wall component 64. In this respect, the backing wall component is inwardly depressible against the force of the fluid acting outwardly thereagainst within the chamber 65; and in more particular terms, the backing wall component is a relatively thin member that is both flexible and resilient. By way of example, the backing wall component 64 may be fabricated from an elastomeric material such as rubber (either natural or synthetic or rubber compositions) having a hardness related to the particular characteristics of the embossing pattern to be imparted to the web 24 by co-action of the platen roller 23 with the respective embossing rollers 20 through 22. Ordinarily, a hardness in the range of about 30 to 60 durometer has been found satisfactory. The backing wall component is reinforced along the inner surface thereof with any one of a variety of materials such as a flexible fabric material (as shown at 66 in Figure 4). By way of illustration, a typical backing wall 64 may have an over-all length slightly in excess of 100 inches, an outer diameter of approximately eight inches and wall thickness of about ¼ of an inch; it may be fabricated of non-marking rubber having reinforcing along the inner surface thereof constituting four layers of rayon fabric disposed on the bias. Certain embodiments of the invention having such specific parameters may have a hardness of from 32 to 37 durometer.

The chamber 65 is essentially hollow throughout its entire length, and the end wall components 62 and 63 are rigid members which, for example, may be formed of steel. The end wall components 62 and 63 are generally in the form of caps respectively having large central openings 67 and 68 therethrough, and inwardly extending annular flanges 69 and 70 having outer surfaces substantially co-extensive in diameter with that of the backing wall 64. The backing wall adjacent its ends is inserted into the flanges 69 and 70 which may have a succession of ridges or annular grooves extending thereabout for clamping engagement with such end portions of the backing wall component.

The respectively associated end portions of the backing wall component are clamped against the inner surfaces of the flanges 69 and 70 to form a gas-tight seal therewith by wedge or clamping elements 71 and 72 that are generally frusto-conical and are drawn outwardly to compressively wedge the end portions of the backing wall against the flanges 69 and 70 by a plurality of cap screws 73 and 74 extending through openings provided therefore in the respectively associated end wall components 62 and 63 and into threaded openings aligned therwith in the clamping elements 71 and 72. The clamping force is of sufficient magnitude to deform the end portions of the backing wall component into the channels of the flanges 69 and 70, as shown in Figure 4, to establish a long path forming a pressure-tight labyrinth-type seal.

The chamber 65 is intended to be filled with a gaseous pressure fluid, usually air, and a filler valve 75 is provided for this purpose in one of the clamping elements the element 71 in the embodiment of the invention being considered. The filler valve 75 may be a conventional check valve such as the type ordinarily associated with automobile tyres, and it has been found that it is only necessary to add compressed air occasionally to the chamber 65. In the usual case, a pressure in the approximate range of 20 to 60 psig is satisfactory. A conventional pressure gauge (not shown) may be associated with one of the end wall components 62 and 63 to provide a visual indication of the contemporary value of the pressure within the chamber.

As is most evident in Figure 3, the platen roller 23 is floatingly supported or confined by the embossing rollers 20 to 22 and has no rigidly fixed axis of rotation. Accordingly, it is the co-operative engagement of the embossing rollers 20 to 22 with the juxtaposed surface of the platen roller 23 that defines the axis of rotation of the latter which enables the platen roller to seek a natural axis of rotation. The apparatus 12 does include end stops that constrain the platen roller 23 against unlimited axial displacements that might tend to be enforced thereon by non-symmetrical loadings resulting from variations in web thickness, variations in the positioning of the adjustment devices 31 and 32, and dimensional variations due to man-

ufacturing tolerances, etc. In the form shown, such end stops comprise adjustable abutments 76 and 77 respectively associated with the frame plates 14 and 15.

In more particular terms, and as shown best in Figure 3, the abutment 76 is in the form of a bolt having a threaded shank extending through a threaded bore or opening in the frame plate 14, and fixed in any position of adjustment by a lock nut 78. The abutment 77 is generally similar, and it includes a bolt having a threaded shank extending through and engaging a threaded boss 79 provided centrally in a closure plate or cover 80, and fixed in any position of adjustment by a lock nut 81. The cover 80 overlies a large central opening 82 in the frame plate 15 which has a diameter slightly greater than the outer diameter of the platen roller 23 so as to permit withdrawal of the latter through the frame plate by removing the cover 80. The cover 80 is removably secured to the frame plate 15 by a plurality of cap screws 83.

The end wall components 62 and 63, and more particularly the clamping elements 71 and 72 associated therewith, are respectively provided with thrust bearings 84 and 85 at the centres thereof that are generally aligned with the abutments 76 and 77 so as to engage the same upon any axial displacements of the platen roller. The thrust bearings 84 and 85 take the form of inserts comprised of a relatively low-friction yet wear-resistant material compressed into ball bearings 86 and 87 in the outer surfaces of the clamping elements 71 and 72. By way of example, the thrust bearings 84 and 85 may be nylon elements having arcuate outer surfaces facing the respectively aligned abutments 76 and 77 for engagement therewith. As shown in Figure 3, the platen roller 23 is somewhat greater in length than the embossing rollers 20 to 22, thereby enabling some axial displacements of the platen roller to be permissible. Accordingly, when the platen roller is initially centred, the abutments 76 and 77 may be spaced slightly from the respectively facing bearings 84 and 85, as shown in Figure 4.

The function of the apparatus 12 is generally apparent from the foregoing description, and assuming the structural assemblage described with the platen roller 23 properly positioned and inflated, a web 24 is threaded through the apparatus so as to pass over the embossing roller 20 and through the nip defined thereby with the platen roller 23, intermediate the platen roller and embossing roller 21, and then between the platen roller and embossing roller 22 extending over the latter so as to be delivered therefrom to the web rewinding apparatus comprising the frame members 10 and 11. The embossing rollers 20 to 22 are each positively driven in synchronism with the rewinding apparatus *via* the drive train including the variable speed drive mechanisms 48 and 52 which are adjusted to assure the requisite tension along the web 24. As the web passes through the successive stations respectively defined by the rollers 20 to 22, each such roller imparts the embossing configuration thereof to the web so that it has the predetermined composite embossing pattern when it leaves the apparatus.

As is most evident in Figure 5, the web 24 is married to the platen roller 23 and backing wall component 64 thereof as the web passes through each station and intermediate the same. Thus, the web 24 is supported in intimate engagement with the backing wall 64 of the platen roller adjacent the entrance to the first operating station, and remains in supported engagement therewith until it leaves the final operating station after the last embossing operation has been performed thereon. As previously noted, such continuity of support for the web 24 enables relatively weak, readily fractured or torn webs to be worked or embossed whereas such webs are not readily processed in conventional apparatus because the elongation or longitudinal stretching enforced thereon tends to break the same and, also, the requirement to withdraw the same from the platen roller intermediate the embossing stations imposes a severe limitation on the strength of webs that can be processed.

In this reference, and as is clear in Figure 5, the localized compressive force applied by each roller 20 through 22 to the backing wall component 64 of the platen roller displaces the backing wall component inwardly against the outwardly acting pressure force, and any such inward displacement is readily accommodated with substantially no change in magnitude of the pressure within the chamber 65 because of the very large volume thereof relative to the very small change in volume occasioned by localized inward displacement of the backing wall component. As a result, there is no outward displacement of a mass of resilient material to necessarily enlarge the circumference of the platen roller, as is found in conventional platen rollers having a rigid steel core enclosed within resilient cover, and which increase in circumference results in a velocity differential as between the platen roller, embossing roller and web that stretches or elongates the latter longitudinally and tends to fracture the same. The free floating characteristics of the platen roller 23 contribute to the capability of the apparatus to accommodate relatively weak webs because it automatically normalizes and equalizes compressive forces about the platen roller and along any web supported thereby.

The multiple workings of the web 24 at the successive stations along the acurate path of

travel defined by the platen roller 23 soften the web and increase the bulk or thickness thereof so that it has a more satisfying feel and texture. Further, sub-dividing the composite embossing pattern into elemental components not only simplifies the construction of each embossing roller, but it also facilitates changing the pattern should this be desired by replacing one or more embossing rollers. Perhaps of greater importance, however, it tends to eliminate the one-sided effect and resultant harshness of the web that occurs when the entire pattern is embossed in a single operation. Obviating this result appears to be attributable to the fact that the web is effectively embossed about the centre plane thereof in contradistinction to the one-sided condition that obtains when a closed pattern is embossed entirely at one time. Also, the reworking of the web that occurs at each successive station tends to attenuate or soften the web after each prior embossing operation.

The platen roller 23 is rotatably driven because of its engagement with the rollers 20 to 22, and because the roller is hollow, it has a relatively low inertia and does not build up excessive heat which is a characteristic of steel-core, resilient-cover platen rollers that are apparently heated because of the mechanical hysteresis of the steel core resulting from working forces imparted thereto. Further, the heavy bearing structures required for the embossing rollers of a conventional embossing apparatus are obviated herein because the loading force required for any one roller is reduced in proportion to the number of embossing stations. Further in this same sense, the embossing rollers can be of lesser strength and therefore of smaller diameter as a result of the reduced loading forces thereon. Changes in loading can be accomplished readily by varying the pressure within the chamber 65, increasing the pressure to increase the loading force, and vice versa. Any particular loading force, and change therein, results in an essentially uniform compressive force along the entire length of the platen roller 23 since it is floatingly supported in contrast to conventional rigid platen rolls which have a fixed axis of rotation and tend to bow intermediate the heavy bearing supports at the ends thereof. Moreover, the backing component 64 of the platen roller readily conforms to any bowing of the respective embossing rollers.

The floating platen roller 23 is supported at three angularly spaced locations in the embodiment shown in Figure 5, but it may be either supported or associated with other numbers of rollers as, for example, the greater number shown in Figure 7. All of the rollers in the embodiment of Figure 7 may be used concurrently, in which case the web is simply worked to a greater extent, thereby enhancing the softness and bulk thereof. However, the rollers may be used selectively or alternatively which adds versatility to the apparatus. In the modified embodiment of Figure 7, the platen roller is denoted with the number 23*a*, and it may be the same both structurally and functionally as the platen roller 23 heretofore described. It is similarly associated with a plurality of angularly spaced embossing rollers 20*a*, 21*a*, and 22*a* which respectively correspond to the previously described rollers 20 to 22.

The modified apparatus 12*a* of Figure 7 includes additional embossing rollers 88*a* and 89*a* which are respectively disposed adjacent the aforementioned rollers. The web 24*a* enters the apparatus about the roller 88*a* and leaves the apparatus from the roller 22*a*, and is maintained in intimate supported engagement with the platen roller 23*a* throughout the entire length extending between and through all of the operating stations. All of the embossing rollers may be positively driven by means of an endless belt 59*a* entrained thereabout, in the manner previously described, and by means of a driving torque delivered to the roller 89*a* *via* an input belt 50*a*. One or more of the five embossing rollers shown may be equipped with adjustment devices 31 and 32 as previously described, so that any such roller so equipped therewith can be displaced from the platen roller 23*a* and will not then co-act therewith. The idler sheave 60*a* associated with the drive belt 59*a* can be arranged to accommodate any such displacement of one or more of the embossing rollers. Otherwise, the modified apparatus 12*a* functions in the same manner as the apparatus 12 heretofore described.

As previously noted, the apparatus is suitable for use with various web materials including paper webs of many types as, for example, those used for toilet tissue, towelling, facial tissue, and Kraft paper of the type used for paper grocery bags. The web may also be polyethylene or other plastic films, webs made of synthetic pulp, laminates, and substantially all other materials where embossing thereof is advantageous.

The apparatus may include static-charge eliminators which are usually located adjacent the discharge side thereof; and it may also include a web guide adjacent the nip of the co-operative rollers 20 and 23 to direct the web. Neither of these structures are shown since they are standard components having no bearing on the present invention. The wedge-type grip defined between the end wall components 62 and 63 and respectively associated clamping elements 71 and 72 is quite tight and requires compression of the clamped end portions of the backing wall component to a substantial extent. Accordingly, it may in many instances be advan-

tageous to provide a special tool for use in displacing the clamping elements relative to their associated end components to an extent necessary for initial engagement of the cap screws 73 and 74.

Also, the adjustment assemblies 31 and 32 may take variant forms including one in which any particular adjustment is maintained as the loading on the roller is released to displace the same relative to the frame components 14 and 15. By way of example, the lock nuts 36 and 36' can be made clamp collars confined in any position of adjustment along the bolts 33 and 33' so that a particular condition of adjustment can be re-attained simply by tightening the bolts until such members 36 and 36' seat against the elements 34 and 34', as shown in Figure 3.

Each of the embossing rollers 20 to 23 may be integral with the shaft or axle associated therewith, and such shafts are made quite long (as shown in Figure 2) at least at one end so that they are interchangeable, thereby enabling any one of the embossing rollers to have the shaft thereof connected directly to the drive shaft 51. As previously noted, the apparatus will operate satisfactorily as long as one of the embossing rollers is driven.

WHAT WE CLAIM IS:—

1. Apparatus for embossing paper and other webs comprising frame structure; a plurality of support members rotatably mounted on the frame structure and at least certain thereof having patterned embossing surfaces engageable with such web to emboss the same with a predetermined configuration, said support members being positioned at angularly spaced locations about a common centre with their axes of rotation oriented in substantially parallel relation, a platen element floatingly confined by the support members with no rigidly fixed axis of rotation and providing therewith facing juxtaposed surfaces engageable with such web to work the same; and means for driving at least one of said support members, said platen element having a backing wall component providing the surface engageable with the web as a backing surface for the embossing process and a pressurizable chamber in communication with the backing wall component along the side thereof opposite its juxtaposed surface to pressure-reinforce the backing wall component with a fluid within the chamber, said backing wall component being depressible in one direction against the force of the fluid acting thereagainst in the opposite direction from within said chamber.

2. Apparatus according to claim 1, in which the platen element further includes end wall components co-operative with the backing wall component to define the pressurizable chamber therewith.

3. Apparatus according to claim 2, in which the support members comprise rollers supported for rotation with respect to the frame structure, said backing wall component being inwardly depressible against the outwardly acting fluid force.

4. Apparatus according to claim 3, in which the platen element provides a substantially gas-tight pressurizable chamber, and is equipped with a valve communicating with the chamber to enable the gaseous pressure therewithin to be regulatively adjusted.

5. Apparatus according to claim 3 or 4, in which the platen element is a substantially hollow roller having a resilient anf flexible peripheral wall provided by said backing wall component.

6. Apparatus according to claim 5, in which the end wall components are rigid.

7. Apparatus according to claim 6, in which the end wall components are fixedly secured to the backing wall component by clamp elements respectively co-operative with the end wall components wedgingly to clamp respective associated end portions of the backing wall component therebetweem.

8. Apparatus according to claim 3, 4, 5, 6 or 7, in which the backing wall component is comprised of rubber having a reinforcing adjacent the surface thereof in communication with the pressurizable chamber and a hardness in the range of from 30 to 60 durometer.

9. Apparatus according to any one of claims 3 to 8, in which the plurality of support rollers includes a plurality of angularly spaced embossing rollers each having a surface thereof disposed in facing juxtaposition with the backing surface of the platen element and having an embossing configuration along its web-engaging surface engageable with such web to emboss the same as aforesaid, whereby during use of the apparatus the composite pattern embossed along such web includes configurations contributed thereto by each of the embossing rollers.

10. Apparatus according to claim 9, in which each of the embossing rollers is substantially rigid and unyielding and has elements of the composite embossing pattern provided along its web-engaging surface.

11. Apparatus according to claim 9 or 10, in which the drive means is arranged for rotatably driving each of the embossing rollers.

12. Apparatus according to any preceding claim, wherein end stops are respectively disposed adjacent the opposite end portions of the platen element to limit axial displacements thereof.

13. Apparatus according to claim 12, wherein the platen element includes a pair of thrust bearing structures respectively carried by the end wall components thereof for co-operation with the end stops to limit axial

displacements of the platen element.

14. Apparatus for embossing paper and other webs comprising frame structure; a plurality of support rollers rotatably carried by the frame structure at angularly spaced locations about a common centre with their axes of rotation oriented in substantially parallel relation, at least certain of the support rollers having patterned embossing surfaces; a deformable platen roller floatingly confined by the support rollers with no rigidly fixed axis of rotation and providing therewith facing juxtaposed surfaces engageable with such web to work the same; and means for rotatably driving at least one of the support rollers.

15. A method of embossing paper or other web, wherein the web is passed through a plurality of successive stations spaced apart along a predetermined path, each of the stations comprising a support roller rotatably carried by a frame and engaging a platen roller to provide therewith facing juxtaposed working surfaces, the support rollers being rotatably carried by the frame structure at angularly spaced locations about a common centre with their axes of rotation oriented in substantially parallel relationship and at least certain of the support rollers having patterned embossing surfaces, the platen roller being floatingly confined by the support rollers with no rigidly fixed axis of rotation, the surface of the platen roller being deformable by the support rollers at each of the successive work stations.

16. A method according to claim 15, in which the support roller has a flexible peripheral wall the deformation of which is controlled by supporting it with gaseous pressure force enabling it to be displaced bodily against the pressure force in response to compressive force exerted thereagainst at each of the stations.

17. A method of working paper webs substantially as herein described with reference to and as illustrated in the accompanying drawings.

18. Apparatus for embossing paper and other webs constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

19. A web when embossed by the method of any one of claims 15 to 17 or with use of the apparatus of any one of claims 1 to 14.

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1409465 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

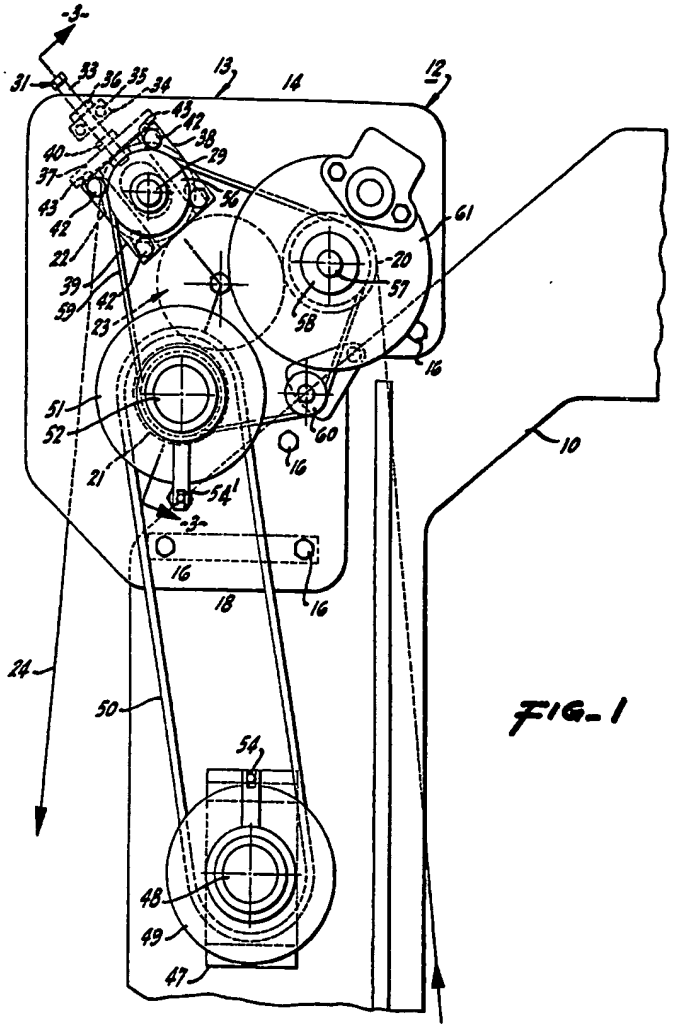


FIG. 1

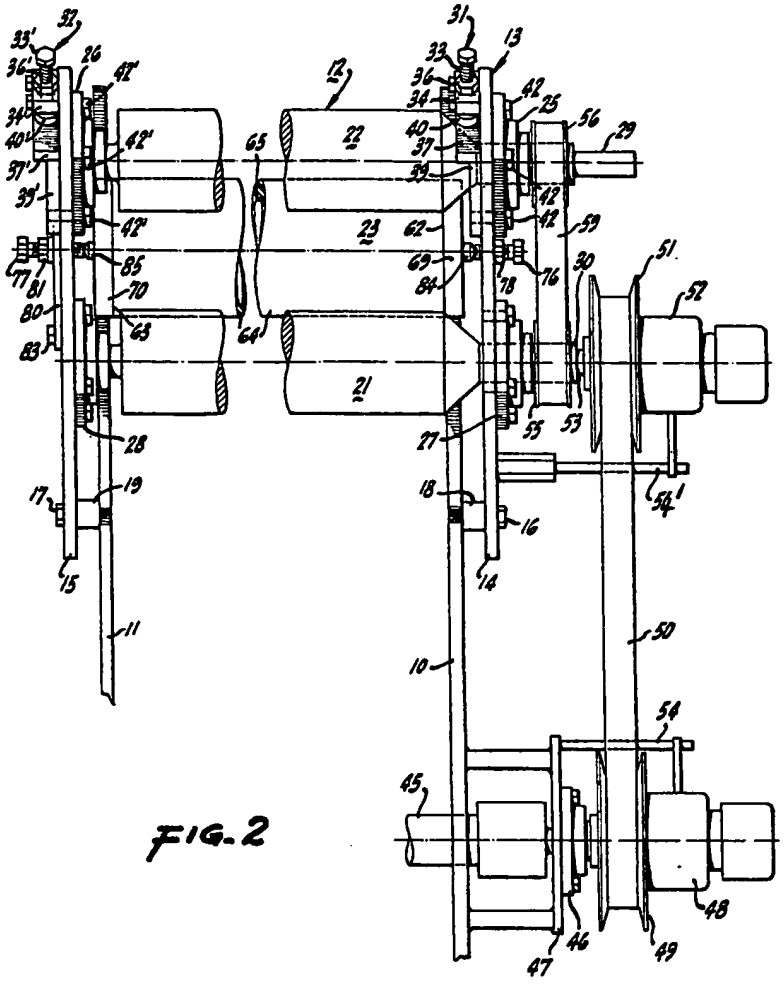


FIG. 2

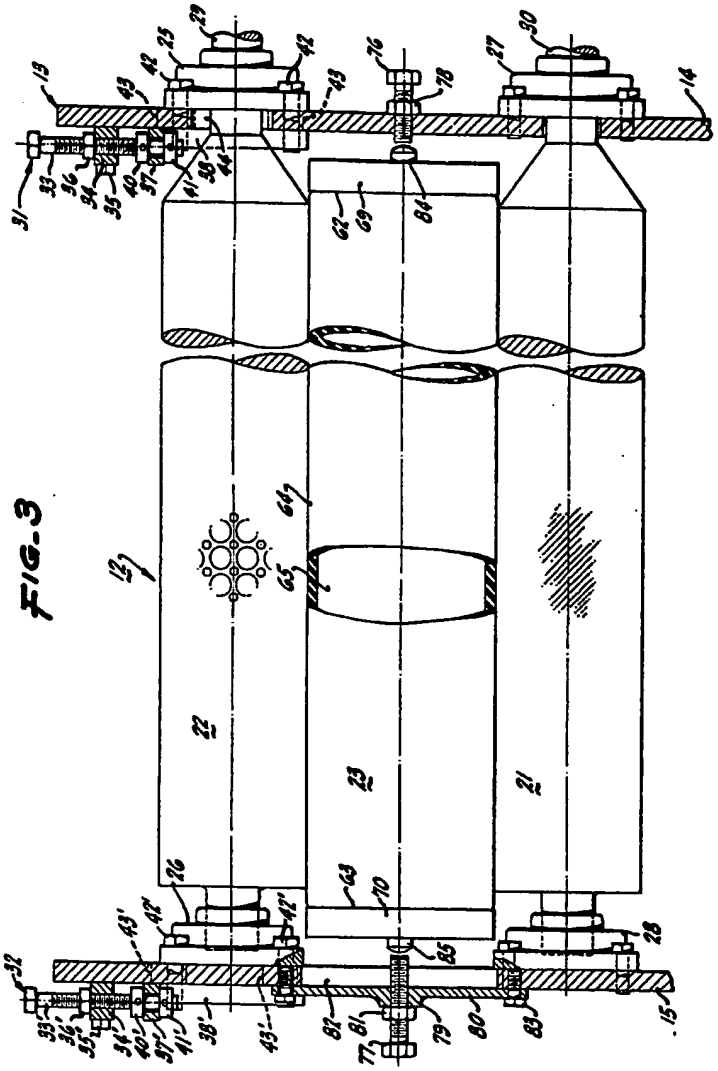
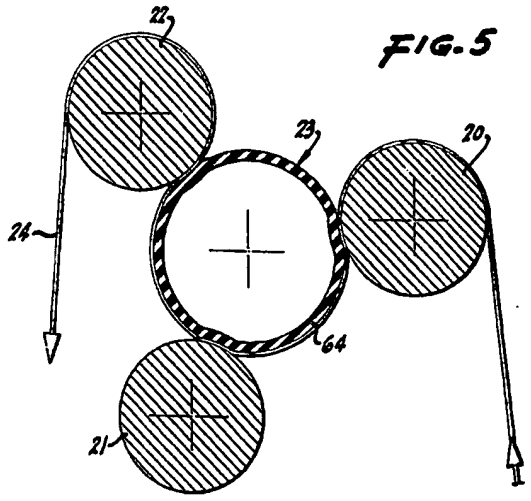


FIG. 3

FIG. 5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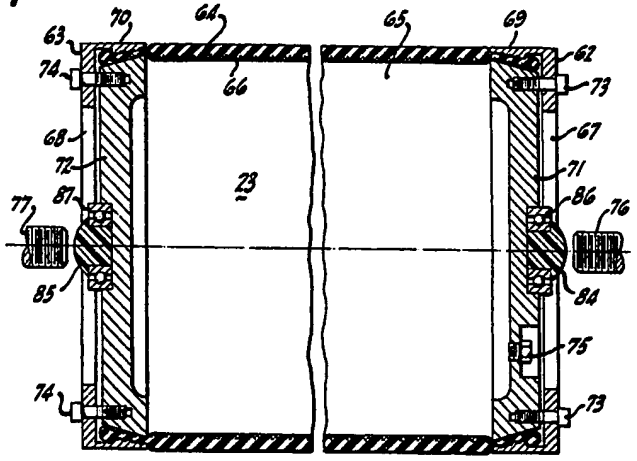
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FIG. 6

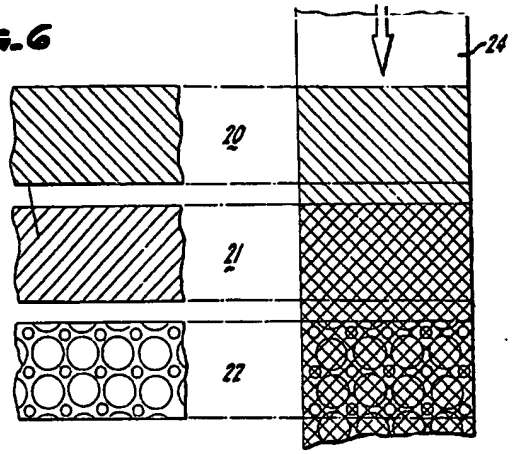

FIG. 7